Nanoindentation analysis and biological characteristics of chitosan-*graft*-poly(ε-caprolactone) copolymer scaffolds

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Tissue engineering is a promising therapeutic approach in medicine for many diseases and injuries. An amphiphilic graft copolymer, based on two of the most widely used components in bio-applications, chitosan (CS) and poly(ε-caprolactone) (PCL), has been developed and investigated for myocardium tissue engineering. This innovative copolymer is biocompatible and biodegradable and displays cationic functional groups that contribute to cell attachment. Moreover, CS can effectively buffer the acidic degradation products of PCL which is advantageous for its application in tissue engineering [1].

In this work, we present the synthesis of a CS-*g*-PCL copolymer, the investigation of its nanomechanical properties during the degradation process, and the examination of its *in vitro* activity for the development of myocardium tissue. Through nanoindentation analysis it was possible to evaluate hardness and Young's modulus values, as well as the time-dependent and viscous behavior of the as prepared samples. Furthermore, we used different mathematical models [2, 3] to correct the elastic modulus values calculated by the Oliver and Pharr model [4].

It was found that the graft copolymer has reduced nanomechanical properties compared to pure CS and PCL. Additional nanoindentation tests and analysis revealed a great effect of the mechanical response of the sample under different loading conditions, suggesting the time-dependent and viscous behavior of the copolymer, as a result of the viscous behavior of the PCL compound. Furthermore, PCL and the graft copolymer were tested after submersion in α-MEM cell culture medium. The nanomechanical properties decreased rapidly with time of immersion due to the hydrolytic degradation of PCL, the porosity and the amorphous regions of the CS-*g*-PCL sample [5]. Despite the large reduction of the nanomechanical properties and the 35% weight loss, the graft copolymer presented sufficient mechanical stability and elastic properties similar to the values reported for soft tissues [6]. Finally, Wharton's jelly mesenchymal stem cells isolated from the inner lining of human umbilical cords were seeded onto the copolymer. Cell proliferation increased after three and seven days in culture. The above results verify that the innovative copolymer possess suitable nanomechanical properties and has thus great potential for soft tissue engineering applications.

References

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